THE RCS ATTITUDE CONTROLLER FOR THE EXO-ATMOSPHERIC AND GUIDED ENTRY PHASES OF THE MARS SCIENCE LABORATORY

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ABSTRACT

The Mars Science Laboratory (MSL) is the next NASA rover mission to Mars. It will launch in 2011 and deliver a ~900 kg mobile science laboratory, a rover named "Curiosity", to the surface of Mars. MSL aims to deliver the rover within a ~20 km landing circular region. MSL uses a guided atmospheric entry capsule to achieve this targeting performance. The entry capsule guidance, navigation and control system employs a set of ejectable balance masses, a descent inertial measurement unit (DIIMU), and a cold gas propulsive reaction control system (RCS). The ejectable balance masses shift the capsule center of mass enabling generation of a lift vector during the atmospheric phase. Control of this lift vector through banking maneuvers enables a guided entry that corrects for down-track and cross-track errors. To achieve this guided entry a navigation filter integrates the DIMU measurements to estimate the position and attitude of the capsule, a guidance law generates bank commands to corrects for down track and cross track position errors, and an attitude control system commands the RCS to track these bank commands.

This paper will describe this attitude control system. Which in addition to tracking bank commands is also responsible for attitude stabilization and control during the exo-atmospheric and entry phases. The controller is formulated as three independent channels in the control frame, which is nominally aligned with the stability frame. Each channel has a feedfoward and a feedback path. The feedforward path enables fast response to large bank commands. The feedback path stabilizes the vehicle angle of attack and sideslip around its trim position, and tracks bank commands. The feedback path uses a PD/D controller structure with attitude and rate deadbands to minimize fuel usage. The performance of this design is demonstrated via simulation.

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